A HORIZONTAL INTENSITY MAGNETIC SURVEY ACROSS THE ROSAMOND FAULT

by

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INTRODUCTION:

This problem was undertaken as an effort to gain an acquaintance with magnetic surveying methods and to test their applicability to the interpretation of geologic structure. The Rosamond fault was suggested by Dr. John P. Buwalda as suitable for investigation. It was selected because it appeared to be a well-defined structure and because the magnetic readings taken across it would be subject to only negligible interference from topographic effects.

The horizontal intensity survey across the Rosamond fault was undertaken in collaboration with Mr. Sidney Schafer, who made corresponding vertical intensity measurements over the same stations as a part of a survey covering Antelope Valley. Measurements of the horizontal component of the magnetic intensity were made at a total of 157 stations.

GEOGRAPHY AND GEOLOGY:

The Elizabeth Lake Quadrangle, in which the Rosamond fault occurs, covers a part of Antelope Valley bounded by the Tehachapi Mountains on the north and the San Gabriel Mountains on the south. The valley is essentially an alluviated desert basin, the western extremity of the Mojave Desert, separated from the adjoining mountain masses by two great master faults which diverge northeastward and southeastward from a point just beyond the western border of the area. Within the included fault block only a few scattered low hills break through the desert basin of alluviation. Prominent among such features are the Rosamond Hills which bound Antelope Valley on the north and are separated from it by the Rosamond fault along their south side.

The geology of the Elizabeth Lake Quadrangle is shown on the accompanying map.[1] Pre-Cambrian igneous and metamorphic rocks are present in the mountains in the southern part of the area. Upon these rocks were deposited Triassic sediments and into them in Jurassic time were intruded great bodies of monzonitic and allied igneous rocks. After an extended period of erosion Tertiary sediments, in part of marine but largely of continental origin, were deposited in parts of the region. At intervals during the Tertiary period considerable quantities of lavas were extruded upon the surface. Tectonic movements deformed the rocks and broke the area into great fault block segments. Active erosion has laid bare the older rocks over most of the area and the products of that erosion have been deposited to depths of a few thousand feet in the central basin segment.

Tectonically the area is a very interesting one. The great San Andreas fault, one of the most persistent structural elements of California, traverses a southeastward course across the south half of the quadrangle and separates the San Gabriel Mountains on the south from the Mojave Desert. Branching from the San Andreas fault at a point immediately to the west of the area, the great Garlock fault passes northeastward, forming the northern boundary of the Mojave Desert.

A great number of smaller faults branch off from the San Andreas fault. One of these, here called the Quartz Hill fault, leaves the San Andreas at Elizabeth Lake and breaks eastward through Portal Ridge to be lost in the alluvium of Antelope Valley. Its course is presumed to extend it along the north face of Quartz Hill, since in that hill are exposed the same rocks which are present in Portal Ridge to the south. Three magnetic profiles were run across the supposed course of the fault between Portal Ridge and the railroad in an attempt to detect the position of its buried trace.

The low Rosamond Hills extend eastward along the northern border of Antelope Valley. The south face of these hills was considered by Johnson[2] to be a long dissected fault scarp. West of the butte at Willow Springs no bedrock is exposed, but the gentle southeast slope of the alluvial fans along the foothills of the Tehachapi is abruptly broken at Willow Springs by a south-facing escarpment, ranging in height between 50 and 100 feet, and extending north 75° west for a distance of about five miles. Numerous springs are located along the course of the fault. The minimum displacement, Simpson states,[1] is at least 800 feet, the height of the present hills, but the actual displacement is probably several times that since bedrock is at a depth of 2000 feet at one place south of the fault.

FIELD PROCEDURE:

The instrument employed in the survey was an Askania horizontal component magnetometer. A value of 30 gammas per scale division was used in making the calculations for magnetic intensity.

Profile lines were laid out at intervals of a few miles across the fault. On these profile lines magnetic readings were taken at stations a quarter of a mile apart. All readings were checked back to and were computed from base station *33 on line D-D' across the Rosamond fault.

Temperature readings were taken at each station, but no correction for temperature was computed and applied separately. Instead all corrections were lumped together into the diurnal variation, and the diurnal variation was corrected for by taking readings at check stations several times a day. This procedure seemed satisfactory and justifiable for the purpose of the survey when it became evident from the readings that the anomalies were of large magnitude.

No attempt was made to correlate the readings with absolute magnetic values for the region, as relative values alone were deemed sufficient for the purpose of the study. A latitude correction of 8 gammas per mile was added going southward and subtracted going northward from the base station. The longitude correction for the horizontal component is negligible and was not applied. In order that there would be no negative values on the isonomalic map, a value of 300 gammas was arbitrarily added to each reading.

During the course of the field work three profiles were made across the Quartz Hill fault and six profiles were made across the Rosamond fault. On the Quartz Hill fault two profiles were run between Portal Ridge and Quartz Hill and a third profile was made two and a half miles east of Quartz Hill. All of the profiles across the Rosamond fault were made to the west of the town of Rosamond. Profile A-A' was run about a mile beyond the end of the fault as it appears on the map.

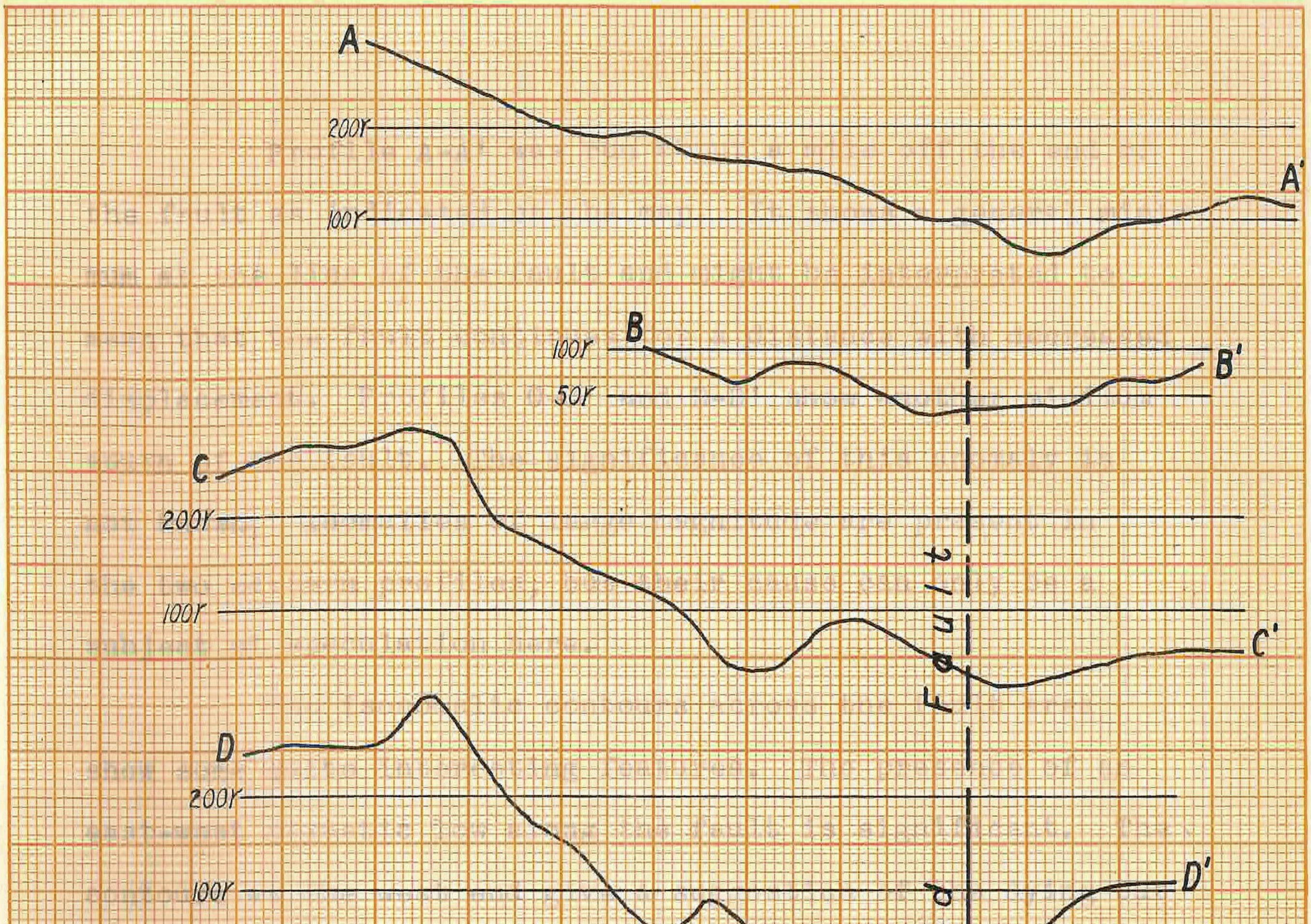
INTERPRETATION OF RESULTS:

In the interpretation of magnetic data the simplest procedure to follow is to compare the observed anomalies with those due to ideal cases. Calculations of anomalies above bodies of various types and in various positions have been made.[3] However, these calculations are generally based on definite assumptions as to size, shape, and the character of the magnetism possessed by the body in question, and such assumptions can hardly be though valid for the particular case of a simple vertical displacement.

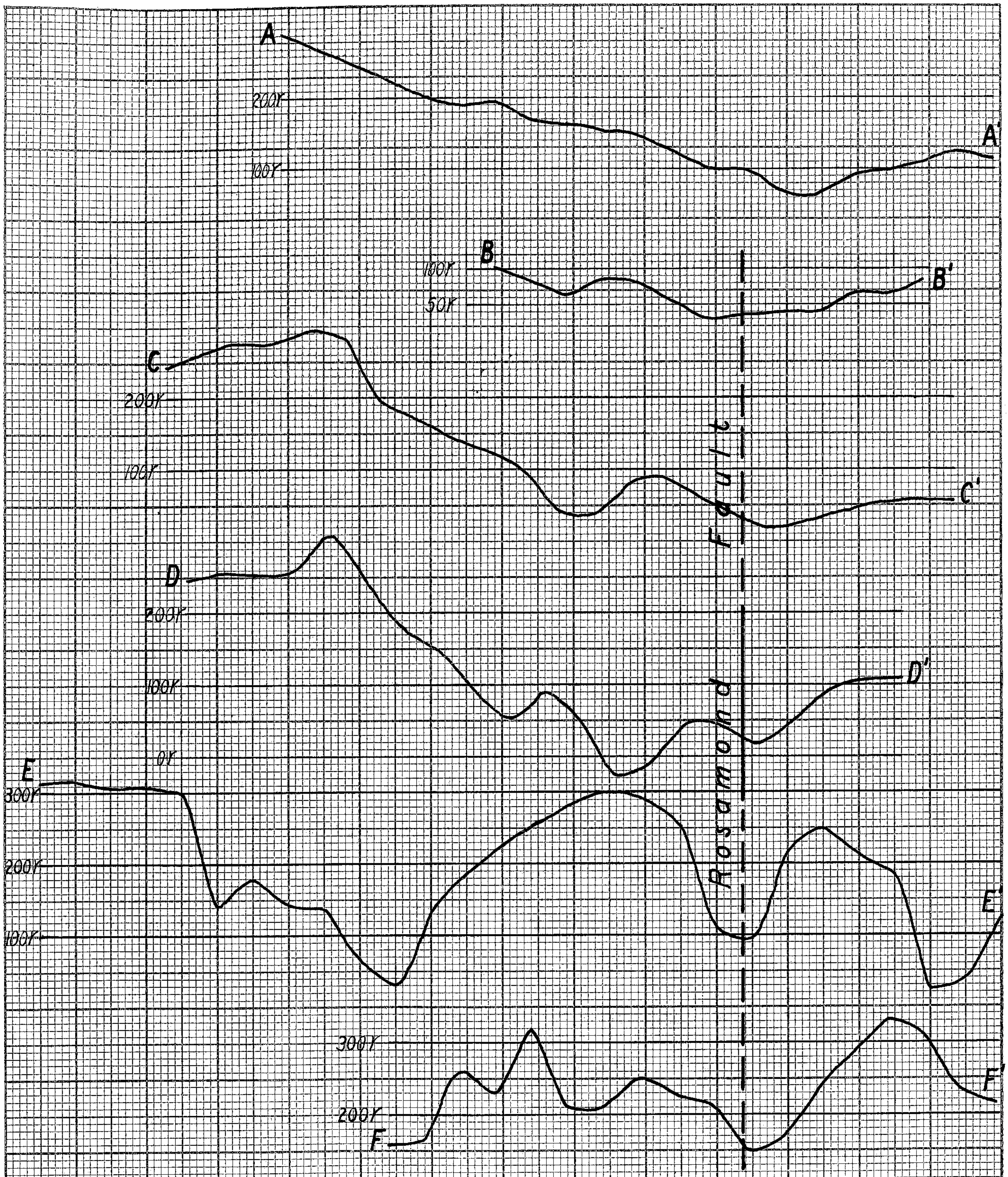
A review of ideal cases in the literature[3] yields many possibilities. Over the edge of a horizontal tabular body and also over a sphere where the inclination is low the horizontal intensity shows a maximum. Over inclined tabular bodies, ellipsoids, and spheres the horizontal intensity is characterized by a maximum and a minimum along the sides of the body. Again it must be remembered that in these cases it is assumed that the magnetic intensity observed is due entirely to the magnetism of a body of specific shape.

A more probable approximation to the actual magnetic field over a vertical displacement is shown by Soske.[4] In this case the horizontal intensity over a horst block shows a maximum over one edge and a minimum over the other. Taking this case as the best approximation to the field over a fault, it is evident that the horizontal intensity curve may show either a maximum or a minimum at the fault.

A glance at the profile curves across the Rosamond fault reveals striking dissimilarities between the two end profiles. However, it is apparent that there is a minimum of some sort on each curve at the fault. The western four profiles show a broad similarity of type. The two eastern profiles are markedly different from the others, but have a general similarity to each other. Increasing complexity is evident toward the east. This might be correlated with conditions of deep alluvium at the west giving way to exposed varied rock types at the east end.



HORIZONTAL INTENSITY MAGNETIC PROFILES
ACROSS ROSAMOND FAULT
1 inch = 1 mile



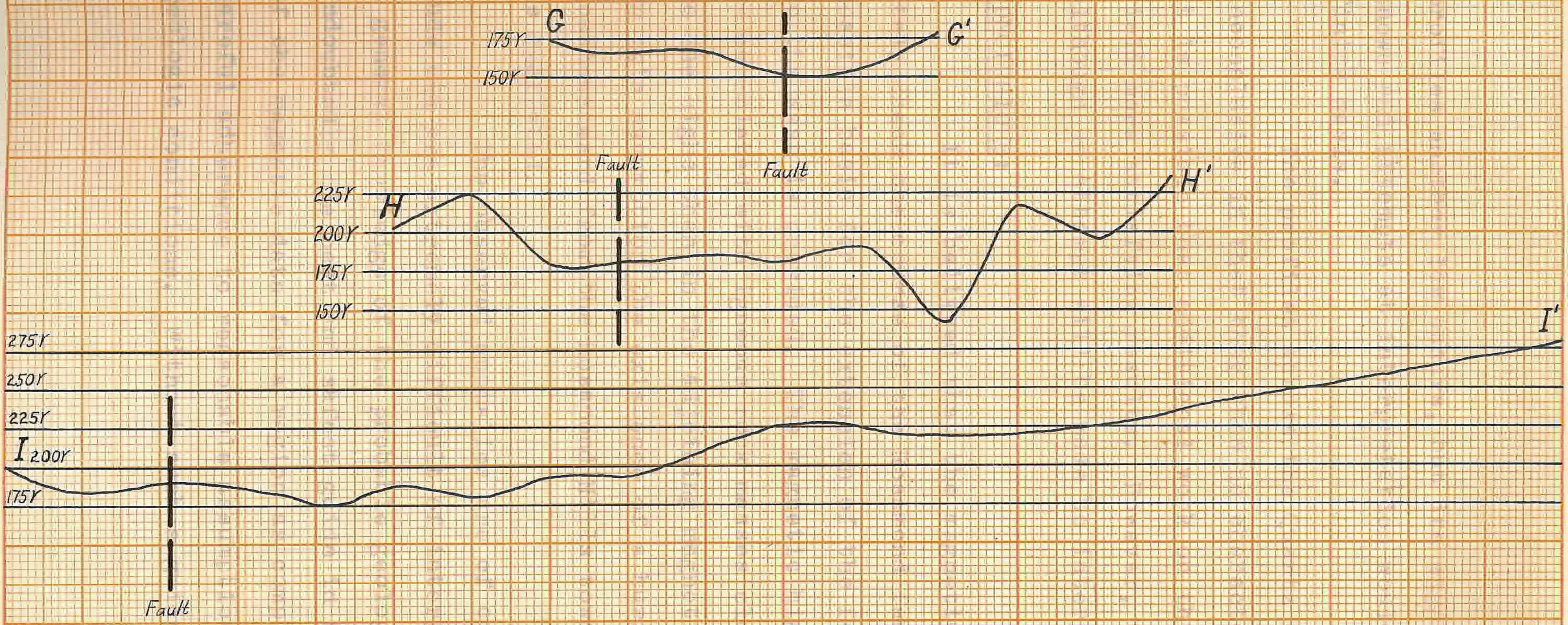
HORIZONTAL INTENSITY MAGNETIC PROFILES

ACROSS ROSAMOND FAULT

1 inch = 1 mile

Profile A-A' was run about a mile off the end of the fault as indicated on the map. It shows a general minimum at the line of the fault and might be interpreted to mean that the fault continues for a distance with decreased displacement. Profiles C-C' and D-D' show another minimum south of the fault. The significance of this anomaly is not known. Anomalies of large magnitude are present in the two eastern profiles, but their cause can only be a subject of speculation here.

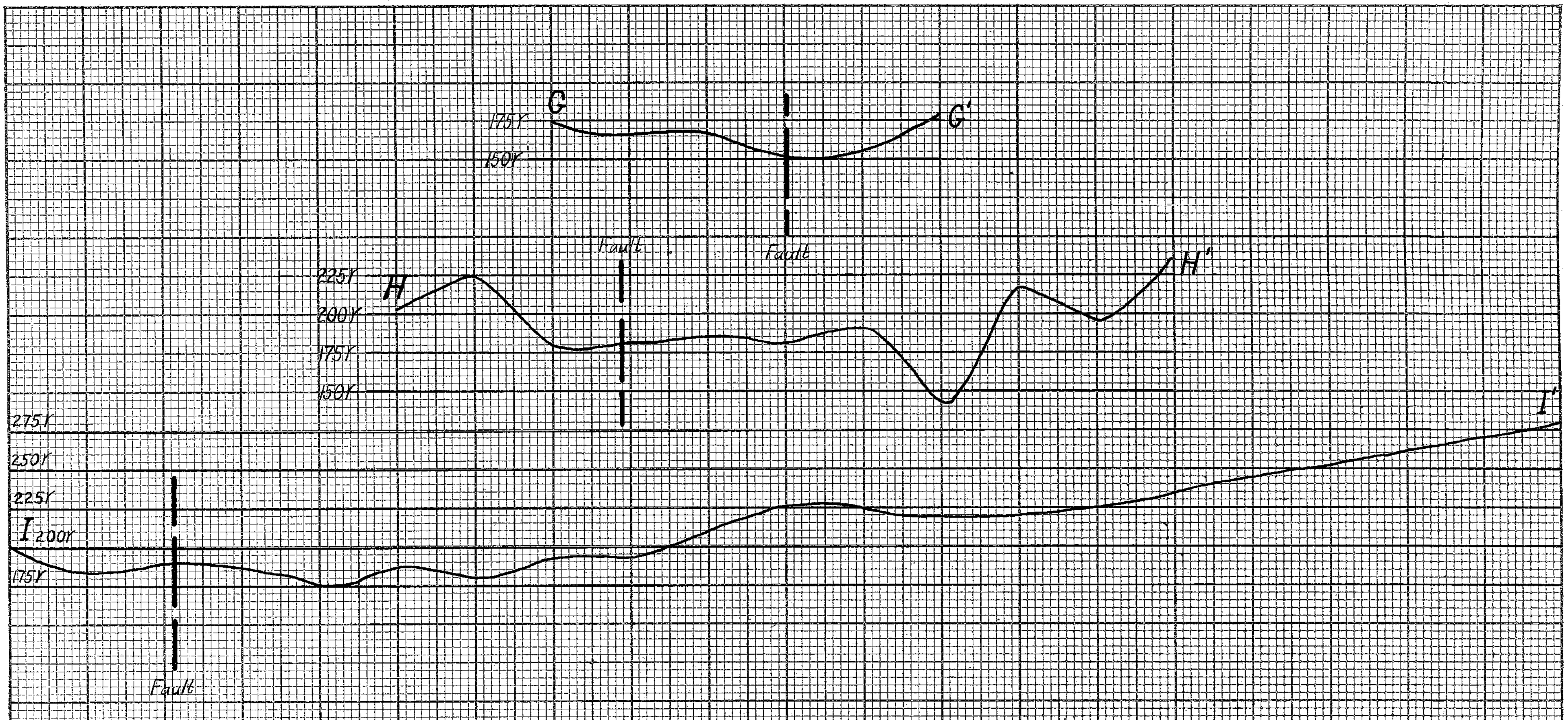
The isonomalic contours across the fault area show some quite interesting features. The presence of an east-west magnetic low along the fault is significant. The contours at the west end give a suggestion of the dying out of the fault in that direction. A definite low branches northeastward from the fault and passes across the north end of the line E-E'. It is significant that its course west of that line is through a zone of faults. The magnetic high in the hills north of the fault is probably due to the increased magnetic susceptibility of the exposed rocks as compared with the alluvium. South of the fault there is a magnetic high which parallels the fault at the eastern profiles and then trends southwestward toward Antelope Buttes. Mr. Schafer found a similar high trend in the vertical intensities and believes it is due to the presence of a buried ridge between Antelope Buttes and the west end of the Rosamond Hills. At the southern end of the eastern



HORIZONTAL INTENSITY MAGNETIC PROFILES

ACROSS QUARTZ HILL FAULT

1 inch = 1/2 mile



HORIZONTAL INTENSITY MAGNETIC PROFILES

ACROSS QUARTZ HILL FAULT

1 inch = 1/2 mile

profiles another low occurs, but its significance is not known and attempts at interpretation would be without definite basis.

The profiles across the Quartz Hill fault are inconclusive in that they show no characteristic anomalies. It is possible that additional work on this fault would yield more satisfying results. However, the data are shown, although no attempt will be made to interpret them.

CONCLUSIONS:

It is believed that the magnetic profiles definitely check the course of the Rosamond fault as mapped. A possible basis for the extension of the fault some distance to the west is provided. The magnetic highs are thought to be correlated with igneous rock masses closer to the surface in the highs than in the adjoining magnetically low areas. On this assumption the existence of a buried ridge extending southwestward from the Rosamond Hills toward Antelope Buttes is suggested.

The observed anomalies are of considerable magnitude and are extremely difficult of interpretation without a general knowledge of the probable geologic conditions. Undoubtedly the best and safest guide in the interpretation of the magnetic data for a region as complex as this is careful adherence to reasonable assumptions as to the actual geologic conditions. Without such a guide interpretation of magnetic anomalies in such a complex region is definitely in the realm of speculation.

ACKNOWLEDGMENT:

Acknowledgment is due Dr. John P. Buwalda for his advice in the selection of a suitable problem and to Dr. Beno Gutenberg, under whose supervision the work was done.

MAGNETIC DATA

Station	Reading	Time	Corrected Reading	Gammas
*1	-0.9	10:20	-0.9	-27
2	-1.2	10:40	-1.2	-34
3	-1.2	10:50	-1.2	-32
4	-1.8	10:58	-1.8	-48
5	-1.8	11:05	-1.8	-46
6	-1.0	11:15	-1.0	-20
*1	-0.9	11:35	-0.9	-27
7	0.1	11:55	0.1	3
8	0.9	12:05	0.8	26
9	0.0	12:15	-0.8	-20
10	-0.6	12:25	-0.8	-18
11	-0.5	12:35	-0.7	-13
12	-0.6	12:45	-0.9	-17
13	-0.4	1:00	-0.7	-9
14	-2.0	1:12	-2.4	-58
15	0.5	1:25	0.1	19
16	-0.3	1:35	-0.7	-3
17	-0.1	1:45	-0.6	2
*1	-0.3	2:10	-0.9	-27
*18	0.0	2:45	0.0	0
19	-0.6	2:55	-0.6	-16
20	-0.5	3:00	-0.5	-11
21	-0.6	3:10	-0.6	-12
22	-1.1	3:17	-1.1	-25
23	-0.8	3:25	-0.8	-14
24	-1.1	3:40	-1.1	-21
25	-0.6	3:50	-0.7	-7
26	-0.7	4:00	-0.8	-8
27	0.3	4:07	0.2	26
28	-0.1	4:15	-0.2	18
29	0.0	4:22	-0.1	25
30	0.5	4:30	0.4	44
31	1.4	4:45	1.3	79
32	0.9	4:52	0.8	60
*18	0.1	5:07	0.0	0
*33	-8.3	9:45	-8.3	-249
34	-10.9	9:55	-10.9	-329
35	-10.1	10:03	-10.2	-310
36	-8.1	10:10	-8.2	-252
37	-8.2	10:20	-8.4	-260
38	-8.8	10:35	-9.1	-283
39	-5.9	10:55	-6.4	-206
40	-5.3	11:07	-5.9	-193
41	-5.0	11:20	-5.7	-189
*33	-7.3	12:10	-8.3	-249
42	-6.0	12:20	-7.0	-208
43	-7.7	12:28	-8.7	-247
44	-6.1	12:35	-7.1	-207

Station	Reading	Time	Corrected Reading	Gammas
45	-4.3	12:43	-5.3	-151
46	-3.4	12:50	-4.4	-122
47	-1.2	1:00	-2.2	-54
48	0.8	1:10	-0.1	11
49	-1.0	1:20	-1.9	-41
50	-1.3	1:30	-2.2	-48
51	-1.2	1:37	-2.1	-43
52	-1.5	1:45	-2.4	-52
*33	-7.4	2:00	-8.3	-249
*53	-3.7	2:25	-4.6	-138
54	-5.5	2:50	-6.4	-190
*33	-6.8	8:40	-8.3	-249
*55	1.3	8:55	-0.2	-6
56	1.4	9:05	-0.1	-1
57	0.9	9:15	-0.6	-14
58	-0.1	9:23	-1.7	-45
59	-1.1	9:30	-2.7	-73
60	-2.5	9:36	-4.1	-113
61	-4.1	9:45	-5.8	-162
62	-7.8	9:50	-9.5	-271
63	-6.7	10:00	-8.4	-236
64	-4.3	10:05	-6.0	-162
65	-4.2	10:12	-5.9	-157
66	-3.0	10:20	-4.8	-122
67	-4.4	10:26	-6.2	-162
68	0.9	10:38	-0.9	-1
69	1.2	10:50	-0.7	7
70	1.1	11:02	-0.8	6
71	1.4	11:14	-0.5	17
72	1.4	11:25	-0.6	16
*55	-1.8	12:00	-0.2	-6
73	-6.3	1:05	-8.0	-260
74	-6.0	1:17	-7.4	-244
75	-5.9	1:29	-7.4	-246
76	-6.6	1:55	-8.0	-258
77	-7.1	2:05	-8.5	-271
78	-7.5	2:15	-8.8	-282
79	-7.2	2:25	-8.5	-267
80	-6.3	2:35	-7.5	-241
81	-5.7	2:50	-6.8	-212
82	-6.0	3:00	-7.1	-219
83	-7.6	3:05	-8.6	-262
84	-7.6	3:12	-8.6	-260
85	-5.8	3:20	-6.7	-201
*33	-7.4	3:27	-8.3	-249
86	-4.8	4:15	-5.9	-175
87	-4.3	4:20	-5.4	-158
88	-3.3	4:28	-4.5	-129
89	-2.7	4:35	-3.9	-109
90	0.0	4:40	-1.2	-26

Station	Reading	Time	Corrected Reading	Gammas
91	0.7	4:45	-0.6	-6
92	0.1	4:52	-1.2	-22
93	-0.1	4:57	-1.4	-26
94	-1.2	5:06	-2.6	-58
*33	-6.9	5:30	-8.3	-249
*55	2.1	9:45	-0.2	-6
95	0.9	10:00	-1.4	-44
96	-3.9	10:09	-6.2	-190
97	-4.3	10:16	-6.6	-204
98	-0.1	10:27	-2.4	-80
99	0.9	10:36	-1.4	-52
100	-0.3	10:46	-2.6	-90
101	-1.2	11:00	-3.4	-116
102	-6.5	11:07	-8.7	-277
103	-5.9	11:15	-8.1	-261
104	-3.3	11:24	-5.5	-175
*55	2.0	12:09	-0.2	-6
*55	2.1	1:09	-0.2	-6
*105	-0.1	1:45	-2.4	-72
106	-0.1	1:58	-2.7	-83
107	-2.3	2:00	-4.9	-151
108	-1.4	2:08	-4.2	-132
109	1.0	2:16	-1.9	-65
110	3.0	2:24	-0.1	-13
111	4.9	2:30	1.6	36
112	4.4	2:40	0.9	13
113	2.1	2:48	-1.6	-64
114	1.7	3:00	-2.2	-84
*105	2.8	3:50	-2.4	-72
115	3.4	4:00	-1.7	-49
116	2.0	4:07	-3.1	-89
117	1.8	4:15	-3.2	-90
118	5.3	4:23	0.4	20
119	2.2	4:31	-2.7	-71
120	3.0	4:39	-1.8	-42
121	-0.2	4:47	-4.9	-133
122	-1.0	5:45	-5.6	-152
*105	2.1	6:00	-2.4	-72
*33	-5.8	8:10	-8.3	-249
123	-3.1	8:56	-5.2	-184
124	-2.9	9:03	-5.0	-176
125	-3.5	9:10	-5.5	-190
126	-3.9	9:15	-5.9	-201
127	-4.3	9:21	-6.2	-208
128	-5.3	9:28	-7.2	-237
129	-5.2	9:35	-7.0	-230
130	-4.4	9:45	-6.1	-201
131	-4.5	9:51	-6.2	-202
132	-3.8	9:58	-5.4	-177

Station	Reading	Time	Corrected Reading	Gammas
133	-3.0	10:03	-4.6	-152
134	-3.0	10:11	-4.5	-147
135	-2.8	10:17	-4.3	-137
136	-2.7	10:23	-4.1	-133
137	-1.9	10:30	-3.2	-104
138	-2.2	10:35	-3.5	-111
139	0.9	10:45	-0.3	-9
140	-0.8	10:53	-1.9	-57
141	-2.0	11:00	-3.1	-93
142	-3.7	11:06	-4.7	-141
143	-5.3	11:12	-6.3	-189
144	-6.5	11:25	-7.4	-222
*33	-7.5	11:32	-8.3	-249
145	-5.8	12:15	-7.1	-233
146	-5.8	12:25	-7.2	-238
147	-4.9	12:35	-6.4	-216
148	-6.2	1:08	-8.1	-261
149	-6.2	1:15	-8.1	-259
150	-6.3	1:22	-8.3	-263
151	-6.5	1:29	-8.6	-270
152	-5.6	1:36	-7.8	-244
153	-4.8	1:42	-7.1	-221
154	-4.7	1:49	-7.0	-216
155	-5.3	1:56	-7.7	-235
156	-4.8	2:03	-7.2	-218
157	-4.0	2:12	-6.6	-198
*33	-5.5	2:25	-8.3	-249

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